Sent: Tue, 26 Sep 2017 12:34:39 -0700
Subject: Re: quick followup trip report from Dan and Winnie, especially for Jonna
From: Jonna Mazet <jkmazet@ucdavis.edu>
To: "William B. Karesh" <karesh@ecohealthalliance.org>

I know Ambassador asked us to engage with him, but somehow that got turfed from Nathan to me -- exhausting (these are just the most recent communications),
J

On Tue, Sep 26, 2017 at 12:03 PM, William B. Karesh <karesh@ecohealthalliance.org> wrote:

> Oh my.
>
> Maybe we should focus on a country that will be more challenging than "his" country.
>
> Sent from my iPhone
> **William B. Karesh, D.V.M**
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>
> ***EcoHealth Alliance leads cutting-edge research into the critical connections between human and wildlife health and delicate ecosystems. With this science we develop solutions that promote conservation and prevent pandemics.***
>
> On Sep 26, 2017, at 8:47 PM, Jonna Mazet <jkmazet@ucdavis.edu> wrote:
>
> > Just FYI,
> > J
> >
> > ---------- Forwarded message ----------
> > From: **Janzen, Daniel H** <djanzen@sas.upenn.edu>
> > Date: Tue, Sep 26, 2017 at 11:40 AM
> > Subject: Re: quick followup trip report from Dan and Winnie, especially for Jonna
> > To: Brooke Watson <watson@ecohealthalliance.org>
> > Cc: Jonna Mazet <jkmazet@ucdavis.edu>, "Hallwachs, Winnie" <whallwac@sas.upenn.edu>, Jake Athanas <jathanas@metabiota.com>, Nathan Wolfe <nwolfe@metabiota.com>, Dennis Carroll <dcarroll@usaid.gov>, Eddy Rubin <erubin@metabiota.com>, [redacted], Peter Daszak <daszak@ecohealthalliance.org>, Román Macaya Hayes <[redacted]>, Cara Chrisman <cchrisman@usaid.gov>
> >
> > Brooke, much thanks for sending, will cogitate.
> > But one quick question.

Do you mean you would actually consider trying to sample all 189 of those mammals? Or is there a short list that is your top priority?

A short comment. Take a spin through the first 6 issues of Ken Burns' Vietnam retrospective on PBS right now. Note the persistent and recurrent thread of massive failure on both sides, causing the deaths of literally hundreds of thousands of soldiers on both sides, which is a direct result of distant top-down planning from senior politicians and politician wannabes, planning that does not match the reality on the ground, a reality clearly visible to both the grunts and the middle level officers in the middle, as well as both sides being quite ignorant of the natural history of themselves and the other sides. Think on it vis a vis your GVP.

The only way I could see your sampling goals having half a chance in CR or any tropical country would be to carefully select a large conserved wild area for its political, logistic, social and biological traits, and then plan the portion of the GVP that can be fit to that. Perhaps with the choice of 3 or 4 such areas in Costa Rica, it just might be possible. Same applies to any New World tropical country. And for certain very carefully selected species, you could track them virologically across many adjacent countries.

Anyway, back to my original question above, please.

Thanks. Dan and Winnie

On Sep 26, 2017, at 10:51 AM, Brooke Watson <watson@ecohealthalliance.org> wrote:

Hi Dan,

Thank you for these detailed updates. I second Jonna that our modeling approach has begun at 30,000 feet - thanks very much for working with us to ground-truth our assumptions about habitat ranges or abundance, and especially to correct outdated data where it still exists.

A basic overview of our selection methodology: based on previous work, we know that distinct geographies and populations of mammals have unique and novel viruses. Thus, we used an algorithm called Marxan (typically used in conservation design planning) to identify unique and complementary assemblages of mammals where we expect to find the highest proportion of novel viruses. Each mammal species was given a certain weight before we selected the sites, based on a PREDICT paper. Mammals with traits that make them more likely to harbor zoonoses - e.g. host range, phylogenetic distance to humans, etc - are given a higher weight before the optimization runs.

After site selection, all mammals in the sampling unit are included in a list, which will then be filtered again by the practicalities on the ground. As you point out, there are some species for which we'll never find 2000 samples, and trying to do so would be a waste of our resources. We'll seek quick wins first, and as we move through the project, we'll be able to update our assumptions about viral richness and refine the strategy accordingly.

I've attached a .csv file of all the species whose ranges fall within the (admittedly arbitrarily-shaped, as you point out) polygon selected by the model, according to the IUCN range data we used. I second your concerns about the habitat data not keeping pace with land conversion - that's a huge potential weakness in our ability to model appropriate places to sample. The chair of the modeling working group is currently aggregating habitat suitability models that will yield more conservative (and thus more accurate) predictions of species ranges, but actual in-country knowledge is even more valuable.

The file includes species name, common name, IUCN status, and a number of other columns. Please let me know if you have any questions or require any additional information - I look forward to your feedback.

Best,

Brooke Watson

On Mon, Sep 25, 2017 at 9:44 PM, Jonna Mazet <jkmazet@ucdavis.edu> wrote:

> Dear Dan,
> Thank you very much for the follow-up and your continued insights and pursuits. I may be backing up Cara and Dennis by phone for the October 4 meeting in support of the discussion. If you'd like, I'd also be very happy to have a call with you in advance of the meeting.

Of course, you may share anything from me with the others. Most have been copied on my responses to you. We all really appreciate the details and concerns you have shared. They are all incredibly important as we decide how and where to move forward. I believe we are only considering CR at the invitation of the government, so while we understand and want to navigate appropriately through all of the channels, we will only consider a project site in CR if it does, in fact, come from the top by invitation. I take from your email that you agree that this invitation and approach is essential. We consider all data to be "owned" by the government of the countries where we work and are released to the public almost immediately (by pre-agreed principles) by the Ministry of the Environment. Therefore, the data and viruses/viral sequences are "owned" by the government but are publicly available, reducing the long-term issues around ownership. When you meet, Dennis can discuss with you the team of pro bono lawyers already working on the ethics, equitable data access, and Nogoya Protocol issues.

I defer to Peter and Brooke (copied) who, as you have pointed out, are looking from a 30,000 foot view from a modeling perspective. Much of what is initially considered from a global perspective will be cut for local practicalities as necessary. That said, **they can send you the initial species list**. I do think we should talk more and discuss options and protocols before any animals are collected or scavenged from freezers. There are a lot of reasons for that, which we can discuss if we do a call or as things develop further. We would love to explore the idea of the trip in the fall if there is a good probability that the GVP will be supported from the national level. I think a trip to see you in Philadelphia first would be very good. Perhaps you and Dennis can discuss when you're together.

Dennis will be at the meeting to present GVP, but your wise concerns and details will be most appreciated. He may need some of his own scientific mafia to support, thus I will try to be available by phone

A revised GVP 2-pager is attached here in case you'd like to circulate.

Hope to speak with you soon,
Jonna

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For scheduling and logistical issues, please contact:
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On Fri, Sep 8, 2017 at 6:28 PM, Janzen, Daniel H <djanzen@sas.upenn.edu> wrote:

> 4 Sep 2017
> UPenn

Dear Jonna, please pardon this unpardonably late (and long, non-concise) update on kite flying in Costa Rica, but it comes with the biopolitics of having long been guests in tropical countries, as well as with me and Winnie being so tangled up in other biopolitical ecosystems that adding yet another, hits substantial in-house roadblocks and high tension wires. We are meeting with Roman, and Dennis Carroll and Charles Bailey at the CR Embassy in Washingon on the afternoon of 4 October, and whatever parts of this conversation that are appropriate will continue then. ***I do need to know if I am free to mention/show both your notes to me and your GVP blurb to them?*** Speaking of the blurb, in Figure 1 the descriptor for both the red and the blue rings reads the same, and I suspect that you did not mean to do that. Perhaps you could send me a new one with that corrected, and pick another color for that descriptor, one

that stands out more readably.

Anyway, it took me longer than anticipated to fly some portions of your kite into the mind of the Minister of the Environment, and other key figures, but we got there. I have also run it very sketchily by two very core members of the Costa Rican virus mafia, as well as a very few very select field biologists very familiar with Costa Rican field and conservation circumstances, as are we. We have a mixed set of reactions to report, and to be very up front, some are not very encouraging at this moment. I will try to group them, though they do not group easily into a and b and c.

What I write below sounds like a long critique of your plans, but it is not. It is a collage of the responses that biopoliticians and biologists in Costa Rica have to the big picture GVP, or something like it, and a variety of details, when I was pressed to explain more than the big picture (Costa Rica gets very tired very quickly of large castles in the sky, and want to hear the nitty-gritty details - budgets, who owns what, what laws are infringed, who will do what, when, and why, etc.). Of course I am not competent to divulge your details of processing methods in a lab somewhere (anywhere, CR or otherwhere), but I am a bit more comfortable in transliterating what I hear from people there and also matching it with our own 54 years of burrowing in that sandbox to get samples (and we observe the more urban lab world).

And none of which that I say/describe below is meant to be an overt or subtle message of "go away". But I am a scientist and you are a scientist, so I have to be flatly honest about the biological and biopolitical ecosystem in which we carry out our research.

****

Biopolitics (hard core biology comes later). Costa Rica has its next presidential election in this coming late Jan-early Feb, and the new government will take over in mid-May 2018. All the senior decision-making system changes at that time (4 year cycles) and there are both a lot of musical chairs and a lot of unknown people entering and leaving the fray at that time. The current government is a lame duck administration, made up in great part by people who are not professional politicians and not wanting to continue in their jobs (importantly, this especially applies to this particular Minister of the Environment). No one seems to have a firm hand on predicting the next government or what will be its attitudes towards environment, conservation, science, bioliteracy, biodevelopment, etc. (one of the Presidential front-runners is currently campaigning on the slogan that "Humans are the most endangered species on the planet, and income and happiness are the most important indices") (THIS to 4.5 million people in a country barely able to sustain 2 m at a reasonable standard of living). Minister of the Environment = Secretary of the Interior, who you would not think of as being relevant to your project, but in Costa Rica is the number one person you need to have on your side. Minister of Health is probably number two. Minister of Science and Technology is probably about the same. Minister of Culture and Minister of Agriculture slightly less so, and then the Rectors of at least three universities.

But one says, but what of the laws and decrees? Decrees come and go with the personal whims of the next government. Laws are observed and skirted according to the policy viewpoints of the multi-sector senior management during a particular 4 year government.

The practical outcomes of this for GVP are that while individuals (university scientists, NGOs, visiting researchers, field personel of all levels of formal education), manage to keep their individual small scale research projects sort of afloat through all this by a lot of fancy footwork and being resigned about speed bumps shitty budgets (and therefore not openly talking about what I am bringing up), something as large as you anticipate for GVP will have to have senior-management level biopolitical green light from a small zoo of key persons, institutions, NGOs, and government agencies. That is unavoidable and do not let someone tell you otherwise. And, this is a very bad time in the 4-year cycle to attempt to get that cross-cultural and cross-agency approval (your project touches a very wide variety of different feudal kingdoms and

their musical chairs). The spring of 2018, once it is becoming clear who are the key players this time around, is the right time (though some of the very in-house discussions can be going on now with someone (whoever) you find to be your key Costa Rican PIs, and that will definitely have to be someones Costa Rican and someones well integrated into the major networks in this small country.

I see two major areas of complexity - getting the samples, and processing-ownership of the results. The PIs are the in-country captains of those ships.

Now, once you have focused on a person to be PI and that person has a small staff to begin to pull this together for CR (**or for that region that you have indicated on your map - which looks right from the classical and typical "outsider looking in way of IUCN, BINGOs, and others who think a tropical country is their playground at 3 pm before they go home for dinner" - but will be impossible as mapped**), and the magnitude of the opportunity (and of course, its budgets) become apparent, there will be at least five of those feudal kingdoms competing for its bipolitical ownership (some exclusively, some just to exert their influence to extract their quota of whatever spin-offs there are). The project will survive or fail depending on how that battlefield is managed and the winners and losers integrated in the event. If you were a single NSF-supported PI who wanted to do a thorough search of the genome of one species of mammal (with the kind of budget and human resources normal for such) it would be fairly straightforward how to plot your way geographically and the required biopolitical steps to carry it out for five years. When you jack it up to many species who will live in many ways in many places and each have different sectors of the system who "own" it (crocodiles and tapirs and coyotes and Liomys mice and Artibeus bats and ocelots are biopolitically totally different beasts) and when the results of your study will become part of multinational syntheses, collages and human sectors, suddenly you are VERY visible both by your budget, your prestige-potential, and your different poker games to be entering into. **And I need to add, the concept of conducting your project for 189 species of mammals or some large subset of them in just one mappable area of CR is literally impossible biopolitically and biologically. Your project will HAVE to be diffuse over a larger area, with foci biopolitially and biologically determined by much in-country discussion and jockeying.**

B. Some biopolitical biological reality.

1. The moment you start talking about sample sizes of 1000-2000 of ANY 100 species in CR, for WHATEVER scientific and quality reasons (most of which will not be understood by anyone, and especially the impacted politicians and administrators) there will be a knee jerk antagonistic/possessive response. Every vertebrate (and a very large number of non-vertebrate animals and all plants), and the square meters it lives on in Costa Rica, is viewed as a possession of someone(s), be it a land owner, a government agency, IUCN, CITES, a national park, a World Heritage Site, a caretaker, a businessman, etc. And because YOU want a sample of it, it must have value, so the reasoning goes. And that possessor(s) will want a slice of that value before you get your sample and after you get your sample. And it is said that there are three countries in the world with the most lawyers per capita - New York City, Israel and Costa Rica.

2. A large number of the 100+ species that you can (**and have, but somehow I do not think I have a list of the species you actually used for your thinking**) reasonably targeted do and can today exist at densities low enough so that your 1k-2k sample may require the entire population or that many times over (CR is the size of West Virginia). What is forgotten by outsiders is this, just as an example. A map may show 100,000 ha of tropical dry forest (e.g., a Holdridge life zone map as you display in your advert). A mammal book will tell you that Sciurus variegatoides is a Costa Rican dry forest squirrel. It is. Several live by our house in ACG. But of that 100,000 ha of dry forest you included mapped, probably not more than 2% is today any longer Sciurus habitat. The rest is agroscape sufficiently trashed biologically that Sciurus just crosses it now and then, if ever (and the same for many other so-called "dry forest

species"). It is not endangered by IUCN or CITES standards (or even hunting regulations) and they could care less. But getting permission to get a sample of any thing from 1000 of them, from all the different people who still think they "own" that squirrel and its genome in one way or another, will be an administrative and social nightmare. Now multiply by 50 species that live in tropical dry forest in Costa Rica (and that is the EASY habitat to work compared to the patches of 20-40 m tall rain forest where the other species of Sciurus are rare as hen's teeth). And lets not even imagine if they are CITES species. BUT, having said that, a carefully structured plan and team of field workers (both biologists and sociologists/politicians) could pull it off for just S. variegatoides IF there is very top down biopolitical green light (which would not have been possible at any time during the current CR 4-year government), and assuming no squirrel got killed. That team will require training ($$), vehicles and field operations ($$), a dedicated coordinator ($$), a small nightmare of in-country administration ($$) and time (and hope to hell that the squirrel population does not get hit with two years of drought as were 2015 and 2016 - where, for example, all of the baby capuchin monkeys died in Sector Santa Rosa of ACG, apparently due to lack of food for kids and moms).

3. I have studied in the field all over the tropics, and these situations are in no way unique to CR, except that in CR, every square meter is owned literally by someone with a high school or better education (or its equivalent), and that same square meter is administratively regulated by one or more administrative systems. This is where the political green light from above really, really matters. CR is not those views to the horizon of largely uninhabited Amazon rain forest (in 1986, I made a map of Costa Rica showing that 49% of it was cattle pasture, and the 25% that is still reasonably wild would fit in one California county (about 12,500 km2). On the other hand, it is precisely because of this close intersection of humanity with what remains, that may allow your GVP to occur in CR (but I would position it quite differently than you innocently have - again, CR is not the upper Amazon or Zaire, biopolitically or biologically). More on how I would position it at the end of this attempt to explain.

4. When the fierce regulations about collecting and research permits from the government were put in place over the past 50 years, for a variety of political hanky panky, the University of Costa Rica (recall, a government agency by budget, but not by admin, AND the home of a lot of the virus capacity and enthusiasm in Costa Rica), escaped having to require some of the same kind of permits required by the rest of the system (but rather, have a UCR internal review committee). These are required whether the PIs are CR residents or tourist biologists parachuted in. Aside from the obvious massive resentment barriers that this generates between different feudal camps as to who can do what where and how, this results in UCR researchers and faculty expressing or feeling that they are immune to a variety of the above referred biopolitical speed bumps, which they can be for their small individual personal projects - but not something of this magnitude. To be blunt, a UCR researcher specialized in big cat viruses can come to ACG and get a couple of frozen road killed ocelots out of the ACG freezer with no fuss or muss. 1000 samples of different ocelot dung or saliva would be a very different matter.

5. So to speak, most, if not all, of your sampling will need to be done in a national park or other kind of protected area, because for the bulk of the area and ecosystems you are talking about, that is the only place where the vertebrates you want still exist in any numbers. ACG has 40 years of encouraging and facilitating research and researchers (though of course not without a history and conflicts always to be resolved), but this is not the case with the other parks, who are variously attempting to dance by protocols written in the 1970's and even earlier, and since embedded in government bureaucracies with horrid budgets. P.S. Who "owns" the virus you seek? Who owns the genome fragments and the tissues that you seek? What is a gene? What is a virus if it is not a gene? What will you do with it? How will we (CR) be compensated for your taking it away? There is no actual modern logical set of laws and regulations written for and forseeing the kind of research you want to do, so they get gerrymandered to cover you (which they do not) and mostly the legal envelope gets bent by an understanding government administrator if there is to be progress. The GVP big job becomes educating that administrator (which takes up perhaps 30% of our waking hours in Costa Rica). Fresh road kill gray fox you

just discovered driving to town? Who has to issue the permit to collect it or its body parts? Its genome? The Ministry of Public Works who owns the road? The National Park administration out of which the fox just walked? The vulture? The UCR biologist who wants it for a genome study and does not want to need a permit at all? Now, try that for a road-kill otter protected under CITES. << real cases this year.

6. Next, who owns the virus sequences you will get and put where and for how long? Can you demonstrate that you will control their commercialization and "share" in the profits with "Costa Rica" (whichever agency or ministry)? Under what biodiversity prospecting laws and regulations will they fall? Research or commercial? Who and how will sign and process each Material Transfer Agreement (MTA) for (each of?) them, and keep track of them for when they are used to generate a vaccine that saves thousands of lives and is worth millions in market value, a major portion of which of course Costa Rica wants as its "fair" quota(s). Achi and Kyoto Protocols raise their heads. The CBD is alive and well. And then when that Zika-like virus that you find in a bat or mosquito gut is shown to kill proliferating glioblastoma stem cells, who owns the patent? And when you apply for the research permit, can you name the species of virus that you plan to collect (find, inventory, discover)? Of course not. Nor can I name the insects I will collect with a Malaise trap, but getting the system to understand and accept that has been hard core biopolitics since about 1995.

7. Next, who is going to hire, maintain, manage, and train the Costa Rican field biologists who will actually capture the animals, get the samples from them, process the samples, ship them to where (a lab in Costa Rica or in California? - you get totally different collaboration and biopolitics, depending on which)? Again, getting 1000 samples of an Indian fruit bat, whether dead or alive, is a breeze, like shopping in a supermarket.

I have been doing mass sampling (of insects and their insect parasites) since 1985, and this field management process has to be a major part of the biopolitical and biological logistics of any large project such as you anticipate, but it can be done (I currently have to fund-raise approximately $750,000/year absolute minimum to cover the 35 field parataxonomists who do the equivalent of your project for me (for insects). I attach two recent papers that may give you some of the flavor of that (Winnie and I, play that role with our 6 months a year in Costa Rica and essentially full time dedication to the topic during the year). There will have to be a Costa Rican "sub-PI" entirely for this field aspect, just as there will have to be a Costa Rican PI who is primarily dealing with all the other stuff mentioned earlier. These two people, at least will have to be both well compensated and to intrinsically want to fulfill these roles - the latter is the only thing that will keep them going through the trials and tribulations. For my research, I studiously stay away from what happens in the lab (Guelph, Smithsonian, 150 taxonomists in the taxasphere), and move the stuff from the field to the users of this information in both science and the public — but for GVP/viruses, I am simply incompetent to comment on that traffic flow.

C. Hard core biology.

8. In an attempt to reflect on the reality of doing this with the one mammal I know well (Liomys salvini, now known as Heteromys salvini — and see , I challenged myself by asking now what it would take to get a non-lethal sample of 2000 L. salvni salvini from CR dry forest by working with my records since 1983.

http://janzen.sas.upenn.edu/TSHP/English/Heteromyidae/Liomys_salvini_Home_Page/English_Text/Liomys_salvini_Eng.html)

In 1983 we began censusing this mouse in ACG dry forest (the only species of terrestrial non-arboreal forest mouse in the ACG dry forest), catching-marking-releasing all individuals in two 4.5 ha plots (primary forest and secondary forest) every year. Each plot contains 529 Sherman live traps, baited with their favorite food (germinating seeds of Enterolobium cyclocarpum), run for 7 every other nights in each plot in January and May. I attach a powerpoint slide with a plot of

their abundance. After 1996, therefore for 21 consecutive years, the normal capture is about 10 new mice per plot in Jan and the same in May. Using just those plots, it would take 50 years to get a sample of 2000 (because we also sampled during the up and down years 1983-1996, we have actually caught and marked a total of about 6,000 individual mice since 1983). Now, the labor involved is our (Winnie and I) for 14 consecutive days in Jan and 14 days in May, and the field time of three very experienced parataxonomists (cost, $16k/year/person) for 36 days per year. Yes, it would be possible to reduce the time required from 50 years to xx years to get 2000 samples, but that would require hiring a large number of parataxonomists, and a very large number more of Sherman live traps spread over a huge area. I should add here that we have a chip out of the ear of about 5,000+ of those Liomys sitting in a -20 freezer (many in ACG, some in the freezer at UCR). Can you get your virus sample out of an ear pinna chip (quite bloody at the moment), and could simultaneously get the genome of that mouse? (we have been saving these chips because we dream of some day being able to do family trees of these mice through their ups, downs, migrations in and out, movements).

9. Now, if there are perhaps 5-10 species of small rodents that are on your wish list, you can multiply the above by ten to get a rough idea, except that most of your other rodents will be arboreal, and those are MUCH harder to catch.

10. If the focal animal were the bats Artibeus jamaicensis and Glossophaga soricina (20 in our house), for example, you are talking about many, many mist net/nights (instead of Sherman trap nights). The reason why it becomes many in many places is because the first night anywhere you may get 5-10-20 bats, but for subsequent nights in the same place, 0-1-2. This is because when you start in a new place, the bats are flying on autopilot so get caught easily, but once they learn that there are obstructions/nets, they switch on their radar and then are rarely caught. They learn from each other. NOT like catching flying foxes in the Old World Tropics.

11. Now, lets move on to the bigger mammals. Please see the second slide in the power point attached. That is mom and her kid. When you figure out how to capture and sample more than 10 of those in five years, let me know. Same for jaguars, tapirs, peccaries (both species). You can probably get a couiple of hundred howler monkeys by patient and very careful darting (it is like darting cows), or sitting and watching their bottoms to get the newly fallen shit, for thousands of hours. But once you have put one spider monkey or one capuchin to sleep, you can forget getting near the rest of that troop for many months or years, and of course the people studying them will be forever upset with you. Macaque monkeys are a breeze. They are not wild. They are stray dogs.

12. For verts of any smallish (or even larger size - e.g. there are two possums in your focal area that are identical to the Virginia possum, one of which it is), it is essential that a bit of tissue (blood is best) is taken to DNA barcode (Sanger sequence with a 640 bp COI piece) each and everyone, and THAT will need to be checked against taxonomically verified (vouchered) samples. There are a small number of people who still believe that they can reliably ID bats and rodents, and they will often be correct (but they will be enjoying their offices in some urban museum or university, not standing in the field) - but sometimes they will be wrong. And, as I am sure is no surprise to you, more and more cases of cryptic species are being turned up as we build the DNA barcode reference libraries. This means that for all your smaller verts (except in cases where we truly know the animal very well, such as Liomys salvini in one place) a few voucher specimens need to be barcoded and also worked over the morphological way to insure that they are what their name suggests they are. This may require more "peripheral" effort than anticipated - e.g., is the Cloud Forest Peromyscus mexicanus on Volcan Rincon de la Vieja really the same as the thing by that name at Monteverde? or in Mexico? This may seem like splitting hairs, but our years of experience with biodiversity prospecting for plant defensive compounds for big pharm says that when you find x or y or z, you want to be awfully sure that when it is "re-sourced", you really are getting the same thing (accusing the same mammal species of carrying the same bug). Costa Rica quickly goes nuclear when you inform the government that some pest or disease officially known from Nicaragua or Panama, and CR has

deluded itself into thinking that it does not occur in CR, and you point out that your taxonomy or natural history or barcodes say it is indeed in CR. As you know, this has all sorts of health, political and economic spin-offs. I canceled a long-planned Africa-Costa Rica conservation field workshop during the Ebola outbreak, for obvious reasons.

13. It occurs to me to ask, when you find viral family x or y in a blood or other tissue sample, how do you KNOW it was in the vert genome and not in a free-rider microbial genome (or even in a contaminant?)

14. I need to go back to your species/sample accumulation curves. There are two aspects. The first is of what value is it to know how **MANY** species of viruses are in mammal x? I would argue that you want to know WHICH species are in mammal x, rather than the number. If there are 24 species of viruses in Liomys salvini in one place and 38 in Ototylomys phyllotis in the same place (both on the IUCN Red List), it makes no difference whatsoever as to the real world probability that one of their viruses will hop into humans some day; way, way too many other variables are involved. I see the "number of species" of viruses as a knee-jerk carry-over from the conservation industry constantly lobbying for more money (largely ineffectively), using that lament because it is unattainable (by them or anyone) and sounds "good" (like "corridors" and "buffer zones"). Perhaps the most useless phrase in conservation is "how horrible it is that we do not even know how many species there are on the planet" - I reply, so what, what will you DO with that numbe if you knew it. Nothing. I do not need to know the number of anything in a forest, place or ecosystem to know that it is worth investing in "saving" for conservation (or not). That there are 30,000,000 or 2 billion species on the planet is absolutely meaningless with respect to any real world process. Whether Costa Rica contains 500,000 or 700,000 species contains no operational information.

15. Getting 1000+ samples of flying foxes and releasing them, or getting 500 piles of fresh Macaque shit, is like going to the supermarket in Philadelphia. Getting 1000 samples of one of the species on your list will be equivalent to getting 1000 throat swabs from the pups of an endangered (red List, CITES) species of seal living only on the north slope of Baffin Island. Now multiply by 100 different species of baby seals. IF I were tasked with getting "all the species of virus" in xx species of CR mammals in a list, I would never start with the "thousands of samples" method, but rather, start with 1-10 individuals KILLED of that species and take them apart very thoroughly. Your sentence "Many of our funders for our proof-of-concept PREDICT project are conservation-related organizations, and therefore their policies and our own ethical guidelines preclude us from killing animals in our sampling process". This is bureaucratic nonsense (pardon my bluntness, please). WE meet it all the time. The speed limit outside of my office is 30 mph. Yesterday, a police car drove by, at least 65 mph. Both limits are required and reasonable. I won't bother you with all the biopolitical nonsense as to why you make that statement, but by your argument, a surgeon would never make a cut. More on this below.

16. When we speak of a "species" in Costa Rica, that species of mammal is likely to occur in many different Life Zones (to use your terminology). In different places there are different populations. 500 years ago, those populations (e.g, howler monkeys, spider monkeys, capuchins, peccaries, tamanduas, Sigmodon hispidus, Artebeus jamaicensis, etc.) were contiguous over many life zones. Today, a given species is broken into small fragments, and each fragment will have different disease histories, anthro-generated histories (hunting, etc.), pop fluctuations, climate variables, etc. If you want 1000 Artibeus samples, do you want them from one large population (somewhere) or pooled across many small fragments of populations barely hanging on in this or that Life Zone fragment? Except for a few species that flourish in human mild disturbance sites (coyotes, Sigmodon, possums, white-tail deer, Liomys, etc.) the only large populations remaining will be in a few of the Areas Silvestres Protegidos in a few of the Areas de Conservacion, which in turn means your choice of areas is not determined by airy-fairy IUCN Life Zone dreams but limited to about 11 places in the country, by harsh realities of biopolitics and 400 years of agricultural assault (the 25% of CR in "forest" is not one big

patch, but a jilllion little patches plus a few big ones).

17. For each of the species in your list, there will be specific ways to get one (or their feces and urine and ??) into a tube, and that will relate to their absolute density, the politics of their ownership, the method and place of anticipating capture, and the kind of budget-human resource envisioned. If you can let me know what you envision, that will be wonderful. Otherwise I will go down your list and take a first pass at it for each species.

18. I realize the lab cleanliness of imagining that each animal will contain yy species of the total pool of viruses of the sort you care about in the host population, and therefore to get to 80-100% of an accumulation curve, you calculate xx sample size. But long before that, you need to do some exploratory thorough figuring out the whole universe in just a very few individuals - before you get yourself committed to the cost, time, and biopolitical energy to talk about 1000-2000 samples per species. Unfortunately, I suspect, the ease of sampling flying foxes and macaque monkeys have distorted your hypotheses for the most basic logistic aspects of the project.

Now, rather than continue to Monday-morning quarterback your hopes and very valid big picture initiative, let me attempt to condense the above and probably a bit more by the suggestion of a very concise generally structured beginning "plan", to be evolved "en camino".

A. Send me your list of species as you envision them, and we pick out three species for which I will attempt to get you one whole fresh animal (or a recently -20 C frozen fresh road kill) sometime between now and the end of February 2018. You take that specimen apart molecularily-exploratorially as thoroughly as possible, using as many different virus family primers as can be done, to both map how much can be found in ONE individual and where in that individual. If you like, one could call this initial exploratory project preparation. You plan next steps as to sample sizes AFTER that. I can go down that list and give you an idea as to which of those species in your list are things that can be gotten for whatever kind of sampling (non-invasive, invasive, killing, etc.) in what sorts of numbers and where (in nearly all cases, it won't be 1000-2000 samples of a species).

B. You and your people come to Costa Rica (San Jose) in the Fall Semester and meet with the CR wild animal virus researchers (the mafia have identified about 5 of them so far) in the universities (all there, I think, but some may be in other institutions). If you are up for this, I will get you names and emails, and I suspect that you all and others know who you would invite to such a meeting (almost without doubt at UCR). I cannot attend because I am here in Philadelphia during the Fall semester (I will have to be in San Jose one day about 28 October, but do not know which day that is, yet, but that day I fear that my life does not belong to me). But I can warn them, if you like, as to your goals. You can hear for yourselves what they think. Without their buy-in, you wiil have no project. Each will want to pull water for their own mill race. What I worry about is the usual phenomenon that different feudal kingdoms will want to capture the project, though you have the power to prevent that, but at the same time it sets you up to be the foreign invader into the science sphere. Tough one.

C. Once I see your list of species, I can make some half-intelligent guesses as to where (which Area de Conservacion) you will want to concentrate your sampling, but that will basically be strongly tweaked by the biopolitical realities that will set in. Whatever, the concept of drawing a polygon around one area of the country in which to do the sampling will simply not work.

D. I do not know how to crack the nut of needing two powerful members of the CR science community to take on the more urban-based PI role and the field-collecting PI role. I know only one person who could possibly handle the field role (actually has a Master's degree in Medical Entomology) if he were willing.

E. For anyone to be involved in this tar baby, they have to have their own agenda. Mine is a) that science-

based environmental considerations get a serious boost by example and deeds (in my terminology, national level biodezelopment), and b) we drift one step closer to the actuality of DNA barcoding the entire country (multicellulars at least, and micro stuff wherever there is agenda - such as yours). Personally, I think a LOT of your list, but certainly not all, could be logistically, biologically and biopolitically conducted in ACG (the field sampling part, not the sequencing and later part) though as you realize, your mapped polygon is to the south of ACG.

F. I do need to know if I can explain your project to the Oct 4 meeting, unless someone else will, and in explaining my thoughts about it to "them" I would want to circulate my thoughts above to "them" as well, and in addition, your nice replies to me.

I stop here, and and happy to attempt to continue converse abouit any of this stuff.

Dan Janzen and Winnie Hallwachs

On Jul 19, 2017, at 9:32 PM, Jonna Mazet <jkmazet@ucdavis.edu> wrote:

Dear Dan & Winnie,

It was a pleasure to speak with you on July 13, and we especially appreciate your willingness to both consider collaborations and "to fly this kite into CR airspace and test the turbulence". We are very excited about the opportunity to work with Costa Rica and hope very much to approach the the biopolitics appropriately from the very beginning. I've copied a few extra people here, including His Excellency Roman Macaya Hayes in response to your email to him, as well as our modeling guru Peter Daszak (EcoHealth Alliance) and our great lead technical staff, Cara Christman (USAID), Brooke Watson (EcoHealth Alliance),and REDACTED (UC Davis). Thank you for your indulgence in these CCs, as all of them will likely be instrumental in following up further on pending discussions.

Based on our discussion, your requests and questions, and your email to me, we have prepared three documents for you:

- First, a description of the methodology and response to your specific questions. This level of detail may be more than you need, but it is responsive to each of your great questions. The content is heavily based on our manuscript in review and second revision for *Science*.
- The other two pieces are in response to your request for a shorter, bulleted "cheat sheet" for the most relevant points for Costa Rica and a general overview of the Global Virome Project concept.

We hope these documents help to improve on the level of detail necessary to move us one step toward working with Costa Rica and Costa Rican organizations and partners to help the world inch toward the end of the pandemic era.

Please let us know what more would be helpful at this point and the appropriate next steps,

Jonna

P.S. Hope your travels were easy.

Jonna AK Mazet, DVM, MPVM, PhD
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